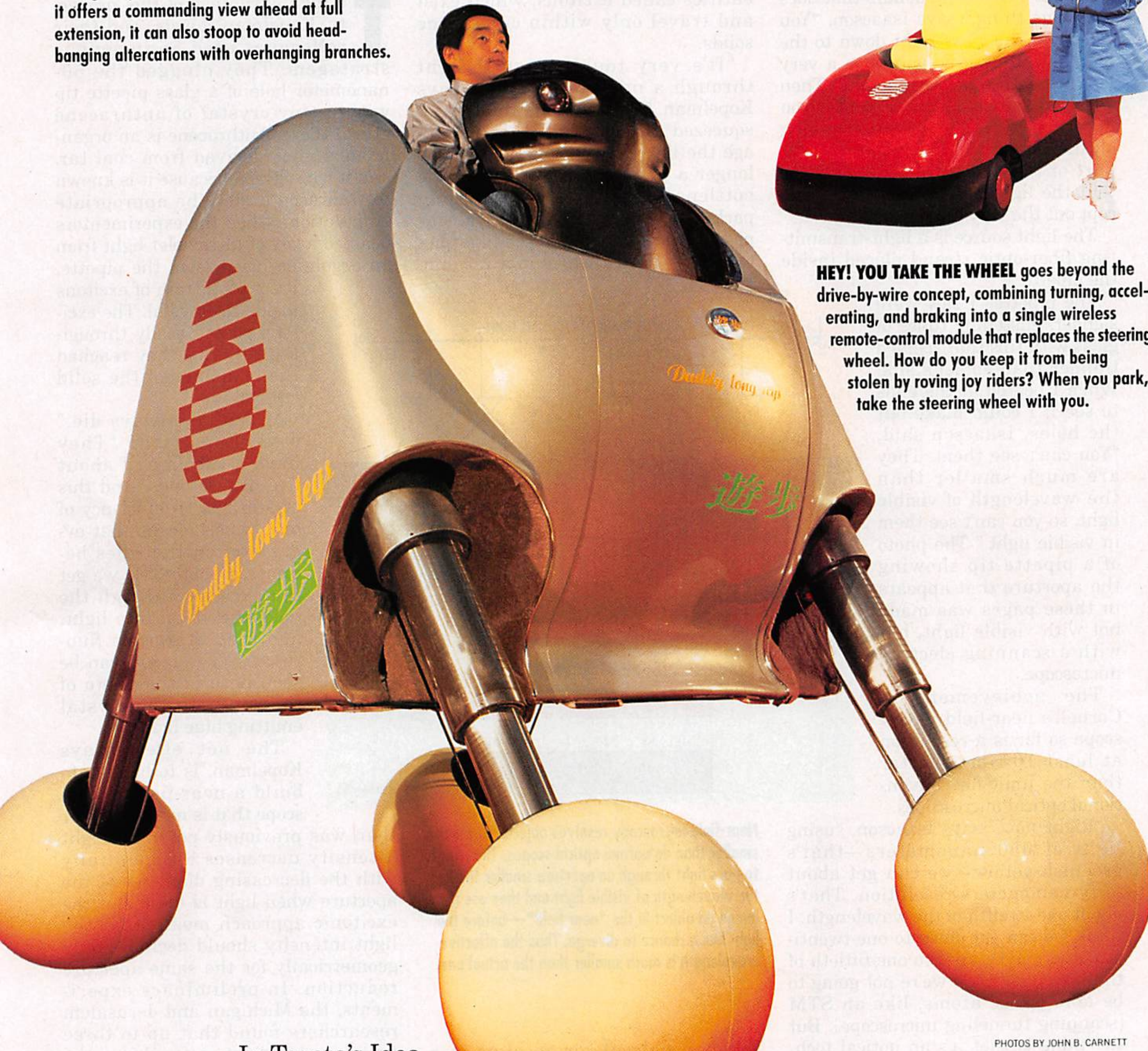


DADDY LONG LEGS shuffles along with a majestic gait on four telescoping legs, avoiding the throngs of pedestrians at sidewalk level. While it offers a commanding view ahead at full extension, it can also stoop to avoid head-banging altercations with overhanging branches.

HEY! YOU TAKE THE WHEEL goes beyond the drive-by-wire concept, combining turning, accelerating, and braking into a single wireless remote-control module that replaces the steering wheel. How do you keep it from being stolen by roving joy riders? When you park, take the steering wheel with you.

PHOTOS BY JOHN B. CARNETT

In Toyota's Idea Expo vehicle competition, teams are disqualified for being too serious or practical.

FUNNY

two pipettes so formed break apart.

"We developed our own little machine to do this and were going to patent it until we learned that biologists can buy an off-the-shelf machine for about a thousand dollars that does the same thing," says Isaacson. "You can taper the glass right down to the end, and draw it so you have a very long tip with a hole in the end. Then you evaporate aluminum so that you deposit a very thin metallic coating on the side of the tip and on the flat part of the end wall. That ensures that the light has nowhere to go except out the very narrow hole."

The light source is a light-transmitting fiber-optic strand placed inside the pipette.

The pipettes I saw were slender, glistening tubes of glass with tips that seemed thinner than spider's silk. When I peered at the ends to see if I could make out the holes, Isaacson said, "You can't see them. They are much smaller than the wavelength of visible light, so you can't see them in visible light." The photo of a pipette tip showing the aperture that appears in these pages was made not with visible light, but with a scanning electron microscope.

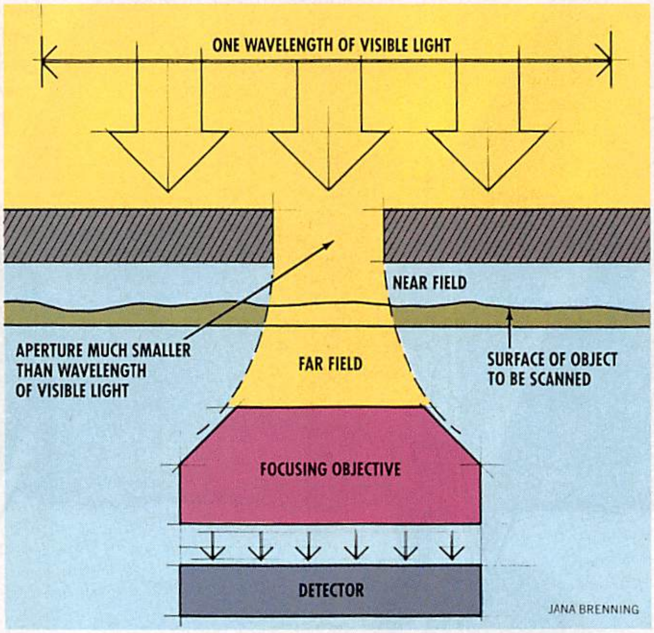
The achievement of Cornell's near-field microscope so far is a resolution at least 10 times better than the limit for conventional optical microscopes.

"Right now," says Isaacson, "using light of 550 nanometers—that's greenish-yellow—we can get about forty-nanometers resolution. That's about one-twelfth of the wavelength. I think we can get down to one-twentieth, and maybe even to one-fiftieth of the wavelength. So we're not going to be able to see atoms, like an STM [scanning tunneling microscope]. But the thing is that it's an optical technique—using light. And light is the key.

"How far down can you go? One of the things that limits you is that the smaller the aperture, the less light goes through, because the wavelength of the light is so much larger than the opening. Maybe you get out only one ten-thousandth of the light you put into the tip. So eventually you reach a fundamental limit: The amount of light going through is so small that it becomes undetectable."

One effort to grapple with that limit is under way in laboratories at Hebrew University in Jerusalem with a team headed by physicist Aaron Lewis, and at the University of Michigan with professor of chemistry Raoul Kopelman. Their technique, Kopelman told me, relies on the production of entities called excitons, which exist and travel only within crystalline solids.

"It's very tough to stuff light through a narrow opening," says Kopelman. "Photons don't want to get squeezed through. But if we repackage the light as excitons, there is no longer a problem about passing the bottleneck. Excitons are traveling packets of energy, but they transfer no mass and no charge. Unlike photons, they cannot travel in a vacuum. When a molecule or an atom in a crystal is bombarded with energy and becomes excited—that is, one of its electrons jumps to a higher energy state—the electron stays where it is with the molecule or atom. But when the electron drops back down to its original energy level, an exciton can hop over to the next molecule and transfer the energy."



Near-field microscopy resolves objects 10 times smaller than do normal optical scopes. The trick is to pass light through an aperture smaller than the wavelength of visible light and then use it to image an object in the "near field"—before the light has a chance to diverge. Thus the effective wavelength is much smaller than the actual one.

One of the differences between the exciton and a photon is size. Because of the dual wave/particle nature of light, the size of a photon of light is comparable with the light's wavelength—about 400 nanometers for the shortest-wavelength visible light. But the size of an exciton is on the order of a molecule, perhaps a nanometer.

To take advantage of this property, Kopelman, Lewis, and their colleagues used an ingenious stratagem. They plugged the 50-nanometer hole of a glass pipette tip with a tiny crystal of anthracene grown there. Anthracene is an organic substance derived from coal tar, and it was chosen because it is known to fluoresce under the appropriate stimulation. When the experimenters beamed a ray of ultraviolet light from an argon-ion laser down the pipette, it set off a train of excitons inside the crystal. The excitons passed easily through the tip until they reached the boundary of the solid crystal.

"Excitons always die," says Kopelman. "They have a lifetime of about five nanoseconds. And this crystal has an efficiency of one, which means that every exciton that dies becomes a photon. So we get the excitons through the hole, they turn into light, and the anthracene fluoresces." (The result can be seen here in the photo of the tip, with the crystal emitting blue light.)

The net effect, says Kopelman, is to be able to build a near-field microscope that is much brighter than was previously possible. Light intensity decreases exponentially with the decreasing diameter of the aperture when light is used. But the excitonic approach means that the light intensity should decrease only geometrically for the same aperture reduction. In preliminary experiments, the Michigan and Jerusalem researchers found that up to three times as much light emerged from the pipette tip with this method as from a hollow tip with the same size hole.

"I believe," Kopelman says, "that we have a technique that can eventually use visible light to image objects down to the size of molecules—on the order of ten angstroms."

Moreover, the availability of such minute yet relatively bright light sources opens the possibility of significant advances in integrated optics. Cheap, compact short-wavelength light sources could replace light-emitting diodes and diode lasers in optical computers, with considerable gains in size and efficiency. PS